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## PRACTICAL CONSIDERATIONS IN THE DEVELOPMENT OF AN AIR QUALITY OFFSETS PROGRAMME

Kristy Langerman<sup>\*1</sup>, Bianca Wernecke<sup>1</sup>, Stuart Piketh<sup>2</sup>, Henry Murray<sup>3</sup>, Hendrik Smith<sup>3</sup>, Christiaan Pauw<sup>3</sup>, Hendrik Snyman<sup>3</sup>, Theo Fisher<sup>4</sup> and Michael Weston<sup>4</sup>

<sup>1</sup> Eskom Holdings SOC Limited, Megawatt Park, Maxwell Drive, Sunninghill, Sandton, [rosske@eskom.co.za](mailto:rosske@eskom.co.za), [wernecb@eskom.co.za](mailto:wernecb@eskom.co.za)

<sup>2</sup> North-West University, Potchefstroom, [stuart.piketj@nwu.ac.za](mailto:stuart.piketj@nwu.ac.za)

<sup>3</sup> The NOVA Institute, 13 Beuke Place, The Willows Ext 14, Pretoria, [henrymurray@nova.org.za](mailto:henrymurray@nova.org.za), [hendriksmith@nova.org.za](mailto:hendriksmith@nova.org.za), [christiaan.pauw@nova.org.za](mailto:christiaan.pauw@nova.org.za), [Hendrik@nova.org.za](mailto:Hendrik@nova.org.za)

<sup>4</sup> E-Science Associates, 9 Victoria Street, Oaklands, Johannesburg, [theo@escience.co.za](mailto:theo@escience.co.za)

Air quality offsets provide a means of improving ambient air quality in dense low income settlements where exposure to harmful levels of pollution is highest – a problem difficult to solve through conventional legislation. Both the implementation of air quality offsets and the legislative framework governing offsets are in their infancy in South Africa. We propose that the implementation of offsets and the development of legislation should proceed in tandem, with the offsets implementation being guided by the legislation and then informing the development of more prescriptive standards. The development of the high-level air quality offsets plan for 12 of Eskom’s coal-fired power stations has highlighted some of the practical aspects that need to be considered in the design of an offsets plan. Eskom has adopted a phased approach to offset implementation – first a small-scale pilot, then one entire settlement, and then a large-scale rollout – to balance the need for rapid implementation with mitigating the risk of rolling out untested interventions. The choice of where offsets are to be implemented can be highly contentious for those who reside in areas not selected. Should we prioritise an area most impacted by emissions from a facility, or an area with the worst ambient air quality? It is still extremely difficult to identify suitable interventions, as very few have been tested at scale. In some areas it is not even known what contribution local sources make to ambient pollution levels. The participation of the affected communities and key stakeholders is obviously crucial to the success of an offsets roll-out, but needs to be appropriate to the level of certainty in project design and approval in order to avoid creating unrealistic expectations. Offsets are more likely to be sustainable if the technologies are robust, and aspects relating to human behaviour, supply chains and socio-economics are considered.

*Keywords:* air quality offsets, domestic coal burning

### 1. Introduction

Air quality offsets are designed to reduce human exposure to harmful levels of air pollution by reducing emissions from local sources, like domestic coal burning and waste burning. An air quality offset is defined in the South Africa *Air Quality Offsets Guideline* (Notice No. 333, 18 March 2016) as ‘an intervention, or interventions, specifically implemented to counterbalance the adverse and residual environmental impact of

atmospheric emissions in order to deliver a net ambient air quality benefit within, but not restricted to, the affected airshed where ambient air quality standards are being or have the potential to be exceeded and whereby opportunities and need for offsetting exist.’ Offsets provide a legal mechanism to improve air quality in dense low income settlements, where the poorest air quality is often found. As of April 2015, the implementation of an air quality offsets programme is a requirement of some Atmospheric Emission Licences, including

Eskom's coal-fired power stations in Mpumalanga and the Free State.

Since air quality offsets are a nascent field, the development of regulations regarding their implementation is in its infancy. Rigorous accounting to evaluate what is deemed an adequate air quality offset for a facility needs to be developed over time, but there are many practical considerations which need to be resolved before we reach this point.

The basis for equivalence in comparing the impact of emissions from a facility to the impact of emission reductions in a community needs to be agreed upon. At the heart of offsets is the understanding that the negative impact of emissions from a facility on the health and well-being of people affected by the emissions should be counterbalanced by the offset intervention. This is in accordance with the right granted in the Constitution of the Republic of South Africa to 'an environment that is not harmful to their health and well-being'. Human health is of course influenced by many factors, many of which may be changed by an offset intervention (for example indoor temperature, access to health care, and even household income). Quality of life, or well-being, is influenced by many more factors.

Effective pollution intake has been proposed by Burger and Piketh (2015) after Zartarian et al. (1997) as the 'offset currency'. In this approach, the amount of pollution from a facility inhaled by the population in the vicinity of a power station should be reduced by a corresponding amount through the implementation of the offset. However, no offsets have yet been implemented at scale, so we do not know by how much an intervention will reduce non-industrial emissions.

The success of an offset can also be determined by the measured improvement in ambient air quality.

The discussion on offset accounting is a theoretical one at the moment, which assumes that the implementer of an offsets intervention has many options available to them with regards to both the spatial extent of the offset roll-out, and the emission reductions which may be achieved through an offset implementation. In reality, there are probably only a few settlements in the vicinity of a facility, with size ranging from a farmstead or few informal dwellings, to an extensive settlement with tens or even hundreds of thousands of households.

Before we get to accurate offset accounting then, there are several practical questions which need to be answered to prioritise the implementation of an offset. Since offset implementation has not progressed past the pilot stage in South Africa, we propose that these practical prioritisations need to be addressed before we are in a position to

formulate more detailed theoretical frameworks to manage the implementation of air quality offsets.

What interventions should be selected for an offsets roll-out? Which settlements should be selected? What are critical factors determining the success of an offsets roll-out? Frameworks to answer some of these key components of an offsets roll-out need will be explored in this paper, with reference to Eskom's Air Quality Offset Implementation Plans submitted in April 2016 (Eskom 2016a-c).

## 2. A practical framework for the implementation of air quality offsets

We would like to propose the following principles for the design of an offsets programme:

- i) Learning through doing: a phased approach to offset implementation.
- ii) Where? Areas are prioritised based on the impact of emissions from the facility on them. Only areas where there is the potential to significantly improve local air quality are considered.
- iii) What? Select the intervention that most effectively reduces the largest local source of pollution.
- iv) Critical success factors: Successful community engagement is the single most important factor that will determine the success of the offset. Sustainability and quality of the intervention are also important.

### 2.1 A phased approach to offset implementation

Since air quality offsets have not been implemented at scale yet, a phased approach is recommended so that learnings can be incorporated as the scale of implementation ramps up, increasing the likelihood of success. The outcome of a roll-out always seems obvious in retrospect, but in reality has many surprising findings.

Eskom is following three stages in its air quality offsets implementation programme. Household emission offsets have been selected as follows (Figure 1):

- i) *Phase 0: Pilot study.* Five interventions designed to reduce domestic coal burning emissions were tested on 120 households in KwaZamokuhle, adjacent to Hendrina town in Mpumalanga. Each house received either a ceiling or a ceiling and insulation on the outer walls, and a low emission coal stove or an LPG stove and heater or an electricity subsidy. Unexpected indicative findings included the willingness of households to trade their coal stoves for LPG appliances (76% of approached households agreed); the

preference of households using LPG to retain their LPG appliances rather than get their old coal stoves back (only 2 out of 40 households wanted their old stove back); and the fact that, if anything, an electricity subsidy increased the amount of coal burnt by a household.

- ii) *Phase 1: Lead implementations (2016-2019).* The most successful interventions identified in the pilot study will be rolled out at three settlements (one per District Municipality in which Eskom's power stations are located) to test the logistics, business and technical processes for implementation at scale.
- iii) *Phase 2: Large-scale roll-out (2018-2025).* The learnings of the lead implementations will be used to refine the interventions and processes, and offsets will then be rolled out at many settlements simultaneously.
- iv) *Phase 3: Monitoring and verification.* The effectiveness of an offsets roll-out needs to be tracked through monitoring, independently verified and reported on to the relevant authorities and affected parties. It is proposed that three indicator domains be monitored before and during the offsets implementation, namely the state of *ambient air*, *emissions* and *quality of life*. Over every monitoring period the project scenario (as it actually took place) will be compared to a credible baseline scenario (i.e. the situation that would have been the case if the project was not implemented).

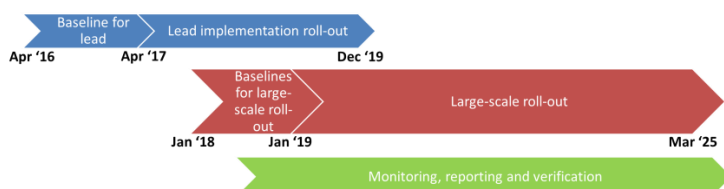


Figure 1: Concept schedule for the implementation of air quality offsets

## 2.2 Area selection

Areas can be prioritised for offset interventions based either on the impact of the facility (settlements most impacted are prioritised), or on the state of ambient air quality (settlements with worst air quality are prioritised). It can be argued that health rights are not transferable from one person to another – if emissions from a facility harm the health of one individual, the facility cannot make amends by improving the health of another individual in another location. For this reason, Eskom has prioritised areas for offsets based on the impact of the facility.

The following area selection criteria are used:

- i) Areas are prioritised based on the impact of emissions from the power station. In some

cases, the cumulative impact of emissions from several power stations needs to be considered.

- ii) Only areas where there is (probably) non-compliance with ambient air quality standards are considered
- iii) Only areas where opportunities for improving ambient air quality through offsetting exist, are considered (i.e. where there are local sources of emissions which significantly impact ambient air quality and can be addressed through offsets)

Criteria (ii) and (iii) align with the definition of air quality offsets in the *South African Air Quality Offsets Guideline*.

### 2.2.1 Example of Kriel Power Station

The use of these area selection criteria is demonstrated with respect to Kriel Power Station. The impact of Kriel's emissions on ambient air quality is shown in Figure 2; isopleths indicate annual average concentrations of the main pollutants emitted from the power station. Settlements are prioritised for offsets based on the impact of the power station's emissions as shown in Table 1:

Table 1: Ranking of settlements impacted by Kriel Power Station's emissions and their eligibility in terms of the area selection criteria

Ranking	Settlement	Non-compliance with AQ standards	Opportunities for offsets exist	Selected?
1	Kriel town	Yes	No	No
2	Thubelihle	Probably	Yes	Yes
3	Rietspruit	Probably	Probably	Yes

Kriel town is the settlement most affected by emissions from Kriel Power Station. Ambient monitoring conducted in Kriel town shows that there is non-compliance with ambient PM10 and PM2.5 standards in the town. However, there is limited opportunity for offsets in Kriel (most households use electricity for heating and service provision is adequate), so Kriel town was not selected for an offsets intervention. Thubelihle and Rietspruit probably have high PM levels due to the presumed prevalence of domestic coal burning in these areas, which makes them suitable candidates for an offsets roll-out.

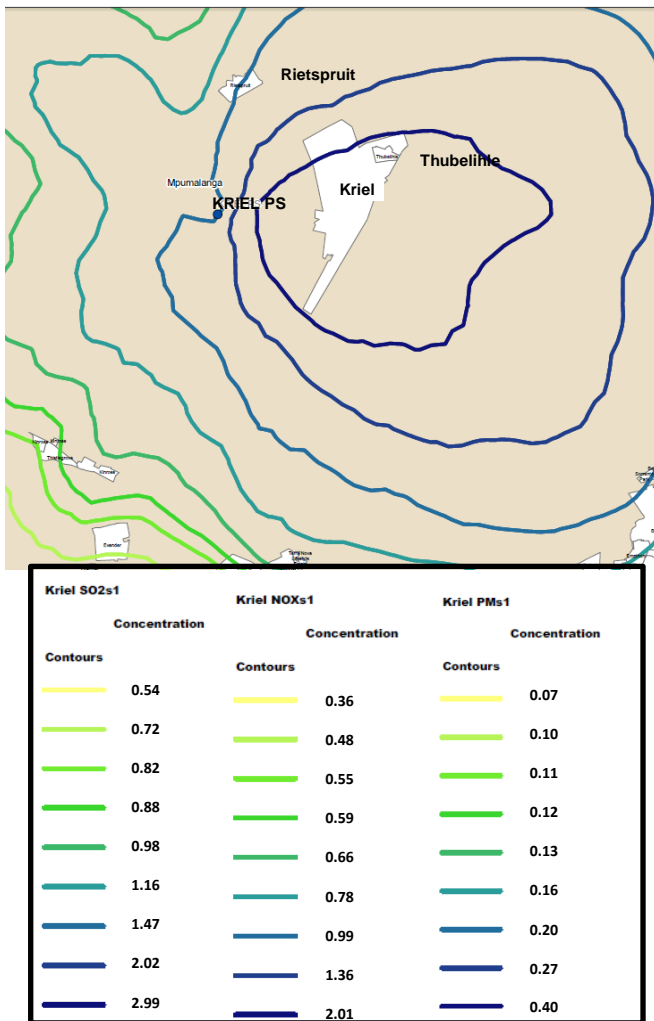


Figure 2. Area of impact of Kriel Power Station's emissions (annual average concentrations in  $\mu\text{g}/\text{m}^3$  from uMoya-NILU, 2014), and locations of settlements in the vicinity.

### 2.2.2 Other considerations in the selection of areas

Eskom has adopted the following additional guidelines when selecting areas for offsets:

- i) An offset should preferably not be rolled out to one section of a community only, to avoid dissatisfaction of excluded people. The large-scale roll-out of the offset needs to include the entire community or at least discrete sections where there are local emissions influencing air quality.
- ii) Eskom will not implement offsets in communities where other industries are already embarking on offset projects.
- iii) While each power station needs to have their own offset project, there needs to be cognisance of the bigger picture when planning the offsets. In some cases, power stations in close proximity to each other impact on an overlapping area (for example, Kriel and Matla

Power Stations impact on very similar areas). In these cases, areas for offsets need to be selected to ensure that all priority settlements are allocated to a power station, although it may not be the power station in closest proximity to them.

Standard RDP houses inhabited by legal occupants in urban areas are obvious candidates for household emission offsets since the houses are of fairly uniform design, and these households often use solid fuels. However, many South Africans live in other types of dwellings and settlements, and offsets also need to be implemented there as far as is feasible.

Farms in the vicinity of the facility need to be candidates for offsets, provided there is non-compliance with ambient air quality standards and opportunities for offsetting exist. A customised offsets intervention will need to be designed for each qualifying farmstead, based on the type of dwellings and energy use.

Rural settlements are also considered candidates for offsets provided ambient air quality standards are exceeded. The intervention will need to be tailored based on dwelling type and fuel use. For example, there is not much scope to switch communities which use freely available wood to a cleaner but more expensive energy source. A low emission wood-burning stove may be the most suitable intervention in this case.

Informal dwellings pose perhaps the greatest challenge for offset implementation. On the one hand, shacks are often illegally located, and their temporary nature means that any intervention may not have a lasting impact (shacks could well be moved, for example). On the other hand, shack dwellers are anticipated to be subjected to some of the worst air quality and are a highly vulnerable group, and as such are most in need of an intervention. Many urban areas have both formal and informal houses. If emissions from informal dwellings are not reduced, an offsets project may fail to significantly improve ambient air quality. As such, Eskom will be adopting a nuanced approach towards informal areas. Areas which are semi-permanent and have been somehow 'officially' established will be considered candidates for an offsets roll-out.

### 2.3 Intervention selection

It is proposed that the main thrust of an offsets roll-out be to reduce emissions from the largest (feasible) local source of emissions. However, there may be other local sources which can be addressed at low cost. Many scientific studies (for example FRIDGE, 2004; MRC, 2008; Lim et al, 2012) show that domestic coal burning has by far the greatest impact on human health on the

Mpumalanga Highveld, and Eskom's pilot study in KwaZamokuhle confirmed that the largest source of PM and SO<sub>2</sub> emissions is domestic burning. In the Vaal, however, there has been a steady move away from domestic coal burning over the last decade or so, and it is estimated that between 10% and 20% of households in lower income areas use coal for cooking and heating (compared to 50-70% of households in lower income areas in Mpumalanga, according to Census 2011 results). Alternative ways to improve local air quality need to be found here, for example addressing local waste burning.

An offsets roll-out should be based on a Programme of Activities, comprising of, as applicable:

- i) *Household interventions*: Emissions from the domestic burning of coal/wood can be reduced through:
  - Assisting households to move to a cleaner source of energy (like liquid petroleum gas, LPG)
  - Providing households with cleaner burning heating and/or cooking devices
  - Reducing the need for heating by better insulating houses
- ii) *Community emission interventions*: Significant local non-household sources of emissions which affect the air quality in the area, for example waste burning or smouldering landfills, need to be identified and then a solution designed.
- iii) *Education and awareness raising*: Continual interaction with the community is needed to ensure that the intervention is used and maintained properly (for example, that LPG heaters are not run throughout the day or with closed windows, and cooking methods are adapted to suit a higher heat LPG stove), and to encourage behavioural change to reduce exposure and smoke generation.
- iv) *Projects in development*: Since it is expected that air quality offsets will be implemented for quite a few years, the interventions need to change as new technologies become available and as circumstances of communities change. Examples of projects which could be developed include:
  - Suitable offset interventions for informal houses
  - Interventions to reduce emissions from local waste burning, for example through improving waste collection or recycling
  - Solutions for farm dwellings and rural settlements which often use free energy sources (like wood)
  - Renewable energy technologies

## 2.4 Critical success factors

A successful offsets roll-out depends mainly on the implementation – the planning is the easy part!

### 2.4.1 *Involvement of local community*

Community support is vital to the success of offsets, and very comprehensive community consultation needs to be undertaken before the implementation of offsets in a community. This consultation should inform the development of a project plan for each community. Aims of the community consultation for a household emission offset include:

- i) Ascertaining what the significant local emission sources are
- ii) Establishing a baseline for a community (how many households are there? What are their energy usage patterns? What type of housing structures do they have?). This baseline should be used to scope the intervention, and evaluate success of the intervention.
- iii) Creating awareness as to how air pollution affects health and what can be done to stay healthy
- iv) Educating the community members on how to best employ and maintain the offset
- v) Getting buy-in from the community

In each community where offsets will be implemented, Eskom will set up a Local Stakeholder Reference Group (LSRG). The LSRG is a forum through which Eskom and the local community communicate with each other.

Furthermore, members of the local community should be recruited, trained and employed to perform as much of the work as possible during an offsets roll-out. Teams which conduct the socio-economic surveys and implement the interventions need to be mainly recruited from the local community, for example. The project team could also help to establish a locally owned company which can assist with the maintenance of the installations in the longer term.

### 2.4.2 *Quality of intervention*

Of course, if an intervention does not work as intended or breaks after a short period, the community will no longer support the initiative and will resort to their old habits. Interventions need to be as durable as possible. They also need to be convenient for households to adopt.

### 2.4.3 *Sustainability*

An offsets intervention needs to be designed so that the uptake does not decline over time, and if possible increases over time. Setting up the supporting environment is key to ensuring the sustainability of an intervention. For example, if households are switched from coal to LPG for heating and cooking, a reliable and affordable

supply of LPG needs to be provided. Aligning with and perhaps accelerating existing trends is also preferred. For example, it is not advisable to supply appliances which burn coal more cleanly if the general trend is a move away from coal burning and up the energy ladder.

#### 2.4.4 Safety

Most project stakeholders and the KwaZamokuhle community expressed concern about the safety of LPG when the topic was first broached. Both actual and perceived safety risks need to be addressed in order to secure support for a project. During Eskom's pilot project in KwaZamokuhle, each household receiving LPG appliances was trained in the safe operation of these appliances by the LPG Safety Association of South Africa, and a member of the local community was trained to become the local LPG training officer. There were no significant safety incidents during the project, and perceptions of the safety of LPG have changed.

### 3. Conclusions

The successful implementation of air quality offsets promises to meaningfully improve the quality of the air breathed by hundreds of thousands of people, and should improve the health of and create employment opportunities for many. The legal framework for offsets should be developed in such a way that encourages, rather than limits, new projects, new approaches, and expansion into new areas. Overly prescriptive regulations which stifle offset projects before they have even been implemented at scale are in no one's best interest, least of all people who burn fuels in their homes and are subjected to some of the worst air quality in the country. We propose that the implementation of offsets and the development of legislation should proceed in tandem, with the implementation informing the development of air quality offset regulations and accounting. Getting agreement on some of the practical aspects of offsets implementation and then testing them in roll-outs on entire settlements is a good first step.

### 4. Acknowledgments

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